IMPLICATIONS OF UNCERTAINTIES IN IPCC ESTIMATES OF RADIATIVE FORCING

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RADIATIVE FORCING OF CLIMATE CHANGE

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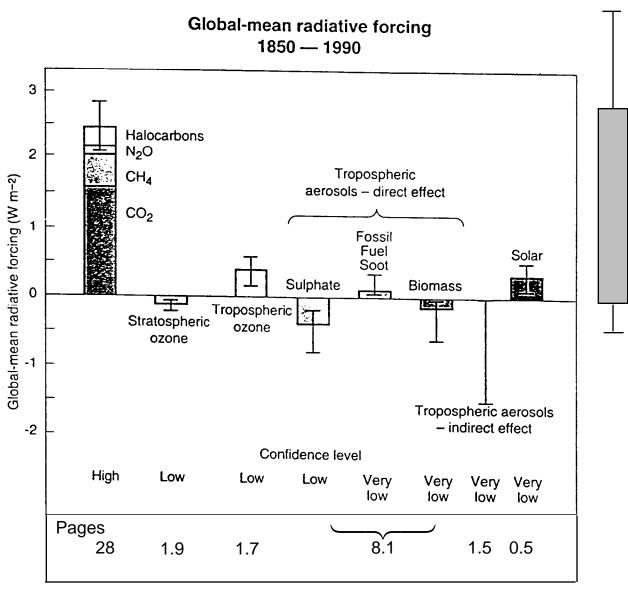
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RADIATIVE FORCING OF CLIMATE CHANGE

IPCC Working Group I Report, 1995



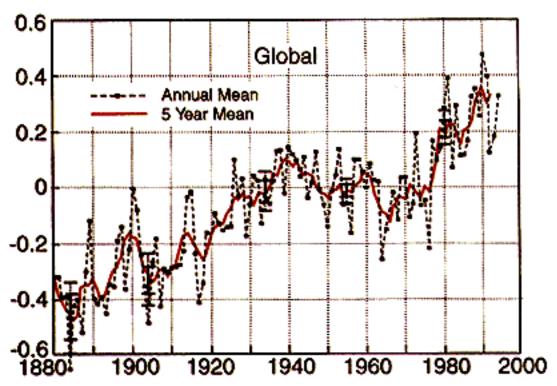
Chemical & Engineering News November 27, 1995

Climate Observations Substantiate Global Warming Models

Bette Hileman, C&EN Washington

Rising atmospheric carbon dioxide levels and receding alpine glaciers support projected global temperature increase





Zero is the 1951--80 average temperature. Source: NASA Goddard Institute for Space Studies.

CHEMICAL & ENGINEERING NEWS ARTICLE ON FORTHCOMING IPCC REPORT:

- 6 Climate observations substantiate global warming models. 9 9
- ⁶Rising atmospheric carbon dioxide levels and receding alpine glaciers support projected global temperature increase. ⁹ ⁹
- 6 On the basis of a variety of evidence a consensus is emerging among researchers that human beings, primarily through their burning of fossil fuels, are already perturbing Earth's climate. 9 9
- ⁶ This consensus, and the evidence that supports it, are documented in the United Nations Intergovernmental Panel on Climate Change's (IPCC) latest report on the science of global warming. ⁹ ⁹
 - -- Chemical & Engineering News, November 27, 1995

STATEMENTS REGARDING AEROSOLS IN CHEMICAL & ENGINEERING NEWS ARTICLE

- There is also broad agreement that ... aerosols -- small particulates consisting of mainly sulfates from the burning of fossil fuels -- act to cool Earth. However, aerosols are different than greenhouse gases because they have very short lifetimes (mostly less than two weeks) in the atmosphere, and rather than causing uniform global cooling, they affect primarily the subcontinental pattern of climate change. Because of their short lifetimes, they cannot build up in the atmosphere and therefore, in the long run, cannot offset much of the warming from greenhouse gases.
- When the models account for the cooling from aerosols, they also reproduce fairly accurately the global warming that has taken place over the past century. Even more important, Hansen says, when aerosols are included the geographic pattern of temperature changes more closely matches the changes in the real world. These tests of the models have given climatologists more confidence in their results. ? ?
 - -- Chemical & Engineering News, November 27, 1995

REBUTTAL TO STATEMENTS REGARDING AEROSOLS IN CHEMICAL & ENGINEERING NEWS ARTICLE

- The article entirely fails to recognize the implication of the uncertainty in aerosol forcing in the context of the broader issue of global climate change, which has been dominated by consideration of greenhouse forcing.
- If the uncertainty in aerosol forcing is as great as stated in the IPCC Report, then it is impossible to attribute warming over the industrial period to anthropogenic forcing over this period and likewise impossible to say that climate observations substantiate global warming models.
- Moreover, if aerosol forcing is offsetting a substantial fraction
 of greenhouse forcing, then it is forcing by a week's worth of
 aerosols that is offsetting forcing by decades' worth of
 greenhouse gas emissions.
- Recognition of this means that the aerosol forcing is all the more important for understanding of climate change over the industrial period.

IMPLICATIONS OF IPCC REPORT REGARDING AEROSOL FORCING

- The present uncertainty in aerosol forcing and the resultant uncertainty in net forcing over the industrial period, calls into question, quantitatively and qualitatively, the entire empirical basis for the anthropogenic greenhouse effect, specifically including the attribution of warming over the industrial period to increased concentrations of greenhouse gases.
- Unless and until the uncertainty in aerosol forcing is substantially reduced the entire issue of anthropogenic climate change over the industrial period is in limbo.
- These conclusions urgently necessitate a major program of research to decrease the uncertainty in aerosol radiative forcing.

IPCC ESTIMATES OF GREENHOUSE GAS AND AEROSOL FORCING AND UNCERTAINTIES

	W m-2
IPCC estimate greenhouse gas forcing	$+2.84 \pm 0.66$
includes long lived GHG's, trop and strat O ₃	
IPCC estimate aerosol forcing	-0.30 ± 1.46
(indirect forcing = 0)	
IPCC estimate solar forcing	$+0.35 \pm 0.21$
IPCC estimate net forcing	+2.89 + 1.35 - 3.32
Possible target uncertainty in aerosol forcing	± 0.66

• With this target uncertainty in aerosol forcing, the total forcing would become 2.89 ± 1.53 W m⁻², or $\sim \pm 50\%$ uncertainty.

REQUIREMENTS OF A PROGRAM TO REDUCE UNCERTAINTY IN CLIMATE FORCING BY ANTHROPOGENIC AEROSOLS

- Quantify the mass loading, chemical properties, microphysical properties, and geographical and vertical distribution of anthropogenic aerosols. (20%) **ACP**
- Quantify the direct radiative forcing of anthropogenic aerosols as a function of the above properties, natural aerosol loading, and other controlling variables. (20%) **ARM**
- Quantify the cloud nucleating properties of aerosols and anthropogenic changes in cloud microphysical properties as a function of the above properties, natural aerosol loading, and other controlling variables. (20%) **ACP**, **ARM**
- Quantify changes in cloud radiative properties as a function of changes in microphysical properties due to anthropogenic aerosols. (20%) ARM
- Quantify differences in climate response to aerosol forcing vs.
 greenhouse gas forcing due to differences in forcing mechanism
 and/or geographical or vertical distribution. ACP, ARM,
 CHAMMP

ELEMENTS OF ACP PROGRAM TO REDUCE UNCERTAINTY IN CLIMATE FORCING BY ANTHROPOGENIC AEROSOLS

Greatly enhanced knowledge of anthropogenic aerosols and their properties

- Composition, especially organic; size dependence
- Microphysical properties: size distribution, CN count, CCN count at a specified supersaturation, nephelometer
- Geographical and vertical distribution especially in marine environment
- Cloud nucleating properties

Emissions of aerosols and aerosol precursors

- Compound-level organic emissions
- Source strengths and microphysical properties of aerosols from biomass burning and windblown dust.

Atmospheric gas to particle conversion

- Rates of pertinent gas-phase reactions
- Nucleation rates: dependence on controlling variables

ELEMENTS OF ACP PROGRAM TO REDUCE UNCERTAINTY IN CLIMATE FORCING BY ANTHROPOGENIC AEROSOLS (Cont'd)

Atmospheric evolution of aerosols

- Coagulation
- Accretion of monomer
- Role of cloud processing

Atmospheric removal processes

- Cloud nucleation
- Fate of cloudwater
- Dry deposition

Model development and evaluation

- Field data for model input and as model evaluation.
- Laboratory studies of specific processes to permit representation in models.